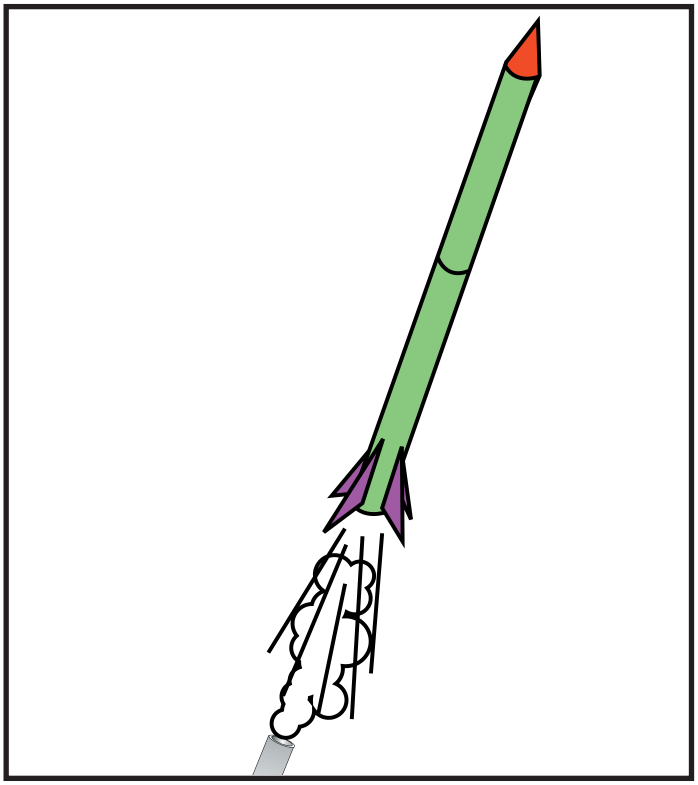


Rocket Activity

Advanced High-Power Paper Rockets

Objective
Design and construct advanced high-power paper rockets for specific flight missions.

Description
Students, working individually or in small teams, select a flight mission (what they want the rocket to do) and design and construct a high-power paper rocket that will achieve the mission. They construct their rocket, predict its performance and the chance of mission success, fly the rocket, and file a post-flight mission report. Missions include achieving high altitude records, landing on a "planetary" target, carrying payloads, testing a rocket recovery system, and more.

National Science Content Standards

Unifying Concepts and Processes
- Evidence, models, and explanation
- Change, constancy, and measurement

Science as Inquiry
- Abilities necessary to do scientific inquiry

Physical Science
- Position and motion of objects
- Motions and forces

Science and Technology
- Abilities of technological design

National Mathematics Content Standards
- Number and Operations
- Geometry
- Measurement
- Data Analysis and Probability

National Mathematics Process Standards
- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

Materials
High-Power Paper Rocket Launcher (see activity)
Bicycle pump with pressure gauge
Paper 8 1/2 X 11 (white or color)
Cellophane tape
White glue
Ruler
Protractor
Beam balance or electronic scale
Scissors
1/2" PVC pipe 24" long for each rocket
Mission Report sheet
Other construction materials as required by the mission

Management

Have students construct and fly a basic paper rocket that will help them to become familiar with rocket design and construction techniques (See the preceding activity.). Discuss possible missions with the students and identify what materials will be needed to fulfill the missions. A day or two before construction begins, have students or teams submit mission proposals. The proposals will identify their mission, what their rocket will look like, how it will function, and what materials they will need for construction. Have the materials ready for the construction days.

Demonstrate how to roll and strengthen a double or triple-long paper tube with white glue. Rockets made with glued body tubes will require a couple of days for the several applications of glue to dry.

On launch day, post a launch schedule. Organize the schedule so that similar missions are flown consecutively. For example, if the objective is to achieve the greatest altitude, teams will have to arrange for tracking students ready to measure the angle from one or more tracking stations (See the Launch Altitude Tracker activity, page 80).

If students have trouble coming up with flight missions, suggest a few possibilities from the list below:

Maximum Altitude
Precision Landing (basketball planet)
Maximum Distance Downrange
Carry Payload
Parachute Recovery

Background

Every space rocket ever built was constructed with specific missions in mind. The Bumper Project back in the 1950s (See Historical chapter), combined a small WAC Corporal rocket with a V2 to test rocket staging, achieve altitude records, and to carry small payloads for investigating the space environment. The Redstone missile was designed for explosive warheads but later adapted to carrying the first American astronaut into space. The Saturn V was designed to carry astronauts and landing craft to the Moon. It, too, was modified and used to launch the first U.S. space station, *Skylab*. The space shuttle, perhaps the most versatile rocket ever designed, was nevertheless a payload and laboratory carrier for low orbit missions. The new *Ares I* will carry crew to orbit and the *Ares V* will carry heavy payloads into orbit or to the Moon and beyond.

Procedure Gluing the Body Tube

1. Begin rolling the body tube as you would when making a basic paper rocket with tape. Overlap two or three sheets of paper as you roll. Small bits of tape can be used to secure the papers to each other while rolling. When the paper is partially wrapped around the PVC tube, squeeze a bead of white glue from one end of the paper tube to the other. Spread the glue and continue rolling the tube. Add more glue as you roll. Be careful not to get any glue on the PVC tube.
2. Allow the glue to dry. If any edges of the paper curl up, add some more glue to them and smooth them down.
3. After the tube is dry, smear glue over the entire tube to strengthen it. Several coatings of glue will yield a very strong body tube. (Optional: Mix food coloring into the glue used for the last layer to add color to the rocket.)
4. If a longer body tube is desired, roll two sheets of paper around the PVC tube at the same time and repeat the gluing process.

Procedure Attaching a Payload Carrier

1. Roll a rocket body as you would for a basic rocket. Use a small disk of paper and several pieces of tape to close off the upper end of the body tube.
2. Roll a second piece of paper around the upper end of the body tube and extend it upward the desired amount to make a hollow tube for holding payload. Tape it in place.
3. Insert the payload and close off the upper end with a standard nose cone.

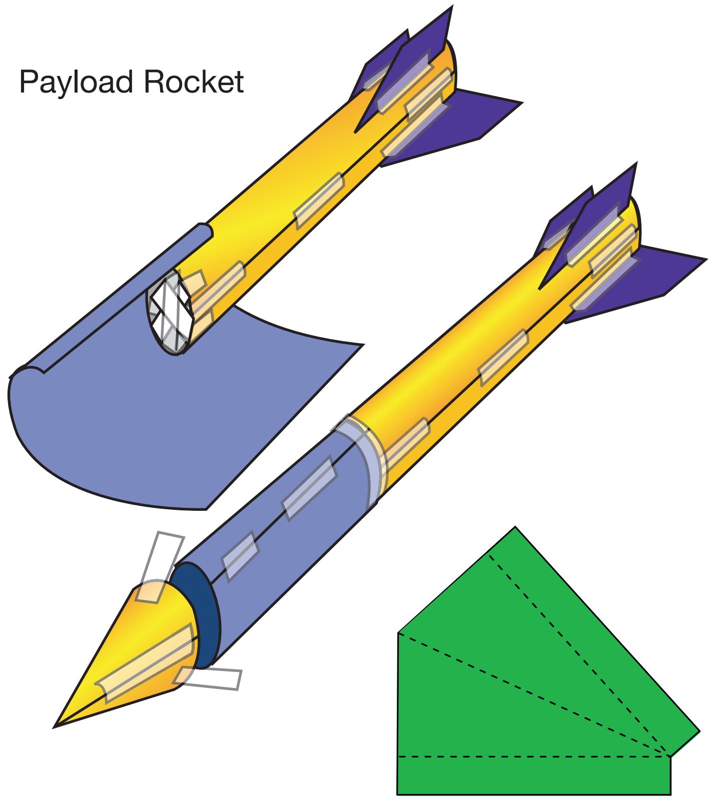
Procedure Making Extra Strong Fins

1. Extra strong fins can be made by folding and gluing multiple layers of paper together. Use

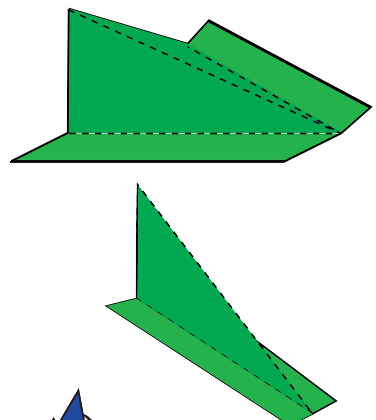
the fold line as the leading or upper edge of the fin.
2. Cut out the desired fin shape and cut small flaps for mounting the fins to the body.
3. Smear glue inside the fin and press with a weight to keep the fin flat during drying.
4. Glue the fins to the rocket tube.

Procedure Making a Parachute Recovery System
1. Create a parachute out of a plastic grocery bag, string, and tape.
2. Place a weight (attached to a string) inside the payload carrier. Lightly fold and place the parachute on top. Stick the nose cone in place but do not tape it. When the rocket noses over, the weight will push out the parachute.
(The weight and parachute must slide easily out of the tube or they will get stuck and not deploy.)

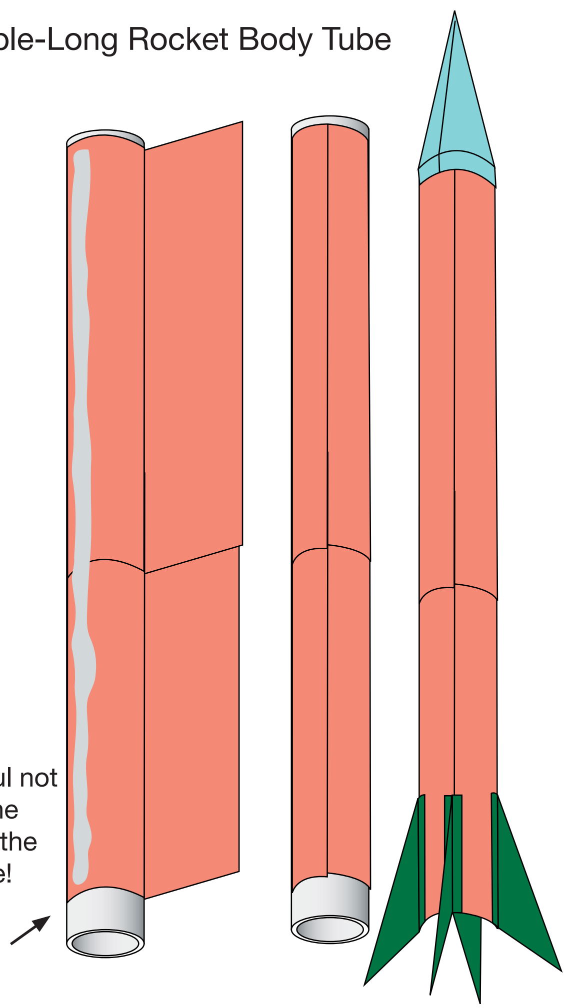
Payload Rocket

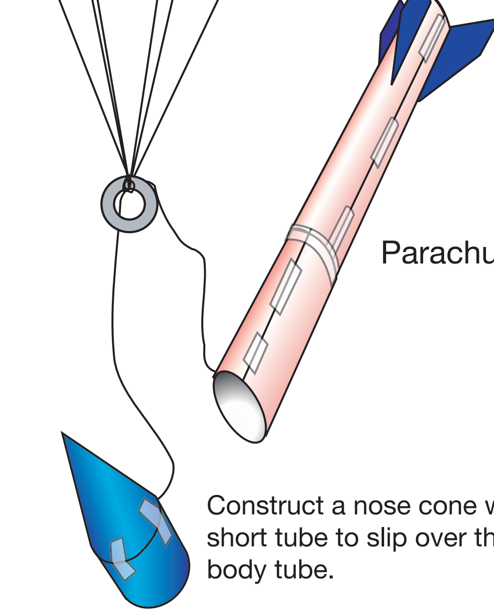


Reinforced Fin



Double-Long Rocket Body Tube





Discussion

- *Why are rockets designed with specific missions in mind?*
  No one rocket design can meet all the needs of spaceflight missions. If a small satellite is to be launched it is much simpler, less expensive, and safer to use a small unmanned rocket for the job. If a big payload, such as a module for the International Space Station, is planned, a larger rocket is required and astronauts may be needed to deploy (release) it from the rocket.
- *What design feature of the rocket has the greatest effect on flight performance?*
  Air rockets fly through the air and therefore have to be designed to create as little air resistance as possible. Crooked fins or a blunt nose cone increases air drag (friction), causing the rocket to slow quickly. The second most important design feature is weight. Weight is a more complicated factor than streamlining. Too much weight, and the rocket will not fly very high. The same effect takes place if the rocket weighs too little. Crumple a piece of paper into a ball and and see how far you can throw it. Crumple a second ball of paper around a nickel throw it again. It will go farther. Very lightweight air rockets have a hard time fighting drag as they fly. Very heavy air rockets have a lot of inertia to overcome.

Assessment

- Evaluate the mission proposal and postflight reports for completeness.
- Have students write a paper on the role drag (friction with the air) plays in the performance of a rocket and how drag can be reduced.
- Compare the space shuttle with the new *Ares V*. Which rocket will have the least amount of drag?

Extensions

- Conduct an “X Prize” style competition. The real X Prize competition led to the first non-government reusable manned spacecraft flights to reach outer space. Use the Internet to learn more about the X Prize Foundation and its current programs. Challenge student teams to create a payload-carrying air rocket that can carry a 100-gram (about 50 small paperclips) payload 50 meters high.

Mission Proposal

Draw a picture of your proposed rocket

Rocket Scientist Names: ______________________

____

____

What is the name of your rocket? ______________

How long will it be in centimeters? ______________

How many fins will it have? ______________

What special features (if any) will it have?

Describe your mission objective:

How will your rocket achieve its objective?

Provide a detailed list of materials and tools needed to build your rocket (include everything):

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Post-Flight Report

Rocket Scientist Names: ______________________________

____

____

What was your Mission Objective?

Provide the specifications of your rocket:

Rocket total length in cm: ______________________________

Fin span (distance from fin tip to fin tip on other side) in cm: ____________________

Mass of the rocket in g: _______________

(If your rocket carried a payload)

Mass of payload in g: ______________

Describe its flight:

Was your rocket successful in meeting its objectives? _______________________

If not, explain why:

What can you do to improve your rocket's performance?